

DEVELOPMENTS IN X-RAY AND NEUTRON DIFFRACTION FACILITIES RELEVANT TO TRANSPORTATION MATERIALS

C.R. Hubbard, T.R. Watkins, S. Spooner, X-L. Wang, E.A. Payzant, and X. Zhu
High Temperature Materials Laboratory
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6064
423-574-4472

The Residual Stress User Center at Oak Ridge National Laboratory is a DOE-designated user facility for the characterization of macro and micro residual stresses in materials. Flexibility and adaptability are required of these ORNL facilities to meet industrial and academic needs. Stress characterization in thin films, functionally graded ceramic-to-metal joints, and weldments in aluminum and steel, for example, have been conducted. Recent developments to be presented include (1) use of grazing incidence x-ray diffraction methods for subsurface strain measurement in ground ceramics, (2) application of through-thickness strain mapping from welding and casting, and (3) design and initial development of a new neutron residual stress facility.

Through thickness, macro residual stress mapping in both research and industrial scale specimens is used to develop and validate FEM models for welding, forging, casting, and dissimilar material joining processes. Stress mapping in a 2" thick by 12x12" plate with a multipass weld and in ceramic-to-metal joints (e.g. 6 mm diam. rods) are representative of the specimen range. Stress relief effects can be quantitatively determined by measuring the same specimen before and after thermal treatment. New facilities with at least a ten-fold enhancement in capabilities are under development and involve focussing monochromators and an array of position sensitive detectors.

Grazing incidence x-ray diffraction utilizing near parallel beam optics has been used to characterize changes in the in-plane, near surface stresses in thin metallic films and in ground ceramics using laboratory and synchrotron x-ray sources. The nondestructive measurement of subsurface stresses provides a unique capability to characterize stresses introduced via grinding and to study the influence of grinding variables. Results for alumina and silicon nitride ground ceramics will be presented.

Research sponsored by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Transportation Technologies, as part of the High Temperature Materials Laboratory User Program, Oak Ridge National Laboratory, managed by Lockheed Martin Energy Research Corp. For the U.S. Department of Energy under contract number DE-AC05-96OR22464.